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AN IMPROVED WATER SUPPLY FOR THE CITY OF EMPORIA.

By A. J. SMITH, City Engineer, Emporia.

THE need of a purer water supply for the cities and towns of eastern Kansas is becoming more important each year, as the population continues to grow, increasing the contamination of our rivers—the present water supply of many towns. There are two reasons for this bad condition of our rivers. The first is the increased number of floods in late years, which, sweeping over the lowlands, wash the filth from the fever-breeding barnyards into the rivers, from which it is pumped into the towns for drinking purposes. Of course, a certain part of these impurities are oxidized by the action of the air, but it is certainly impossible for it all to be removed in this way.

The second reason is the manner of disposal of the city sewage. As a town increases in size there must be some way to get rid of the increased sewage. In most towns this is done in the easiest and cheapest way, by dumping it into the nearest stream. This is true of Emporia and the Neosho river, as well as most other towns in eastern Kansas.

In the fall of 1907 the Emporia authorities began to realize the dangers of river water for drinking purposes. After some discussion, the city council appropriated $300 for the purpose of prospecting for and testing the underflow in the gravel beds underlying the valleys of both the Neosho and Cottonwood rivers, which flow near the city. The engineering department was instructed to carry on these tests, and as head of that department I had full charge of the work.

In order to determine the quantity of water that could be secured it was necessary to know the width and thickness of the gravel deposits and the percentage of voids contained therein; also the direction and velocity of the flow of the water through it. In determining the quality of the water a chemical analysis was made; also, for comparison, a parallel chemical analysis of water from both the Cottonwood and Neosho rivers and from the hydrants in the city.

The methods used in the prospecting were modifications of those devised by Prof. Charles S. Sclichter of the United States Geological Survey, the manner of sinking the wells, however, being entirely different. In sinking these wells a common seven-inch post auger was used for boring down to the gravel, which was found at a depth of from twenty-five to thirty feet. On striking the gravel a casing of five-inch gas pipe was put in the well. This casing was then sunk to solid rock by bailing the gravel from under or within it, in the following manner: Through a pulley at the top of a tripod derrick a rope is strung, with one end attached to a bailer. This bailer is similar to the sand buckets used by well drillers, having a valve at the bottom. In addition to this it has a plunger that works up and down inside the bucket, creating a suction through the valve in the bottom, so that by pulling a few times on the rope a quantity of gravel is drawn into the bailer. It is then pulled to the surface and dumped. The casing settles down as the gravel is taken from under it, until it rests on solid rock or shale. When all the gravel was removed from inside of the casing a four-inch sheet-iron casing, with a four-foot expanded metal screen on the bottom, was let down in the well, and the outside casing was pulled by means of a block and tackle.

For determining the velocity and direction of the flow, four wells were drilled in the following manner: One in the center of a circle having a radius of six feet; then three other wells were put down three feet apart on the circumference of this circle, in the direction from the center well in which the current was supposed to pass. Salt was then placed in the center well. Samples of water were taken every hour, or oftener, from the other wells and tested for chlorine. When an increase of chlorine was observed in the water from one of the wells, it was known to have passed a distance of six feet, and the location of the well in which the chlorine first appeared gave the direction of the flow.

It was learned through these test wells that the water-bearing gravel bed of the Neosho river valley were about two and one-half miles wide and averaged about six feet in thickness; also that the flow was toward the southeast at an average rate of twelve feet per day. In general, the gravel at the top of the bed was filled with mud or clay; a few feet lower the interstices were more open and filled with water. In many places sand having the properties of quicksand was encountered for several feet, but coarse gravel was invariably found overlying the rock or shale at the bottom.

After determining that the quantity and quality of the water was satisfactory for supply for the city, there remained the necessary problem of collecting the water from a wide area and delivering it to an accessible point near the pumping station. After the consideration of several different plans, it was decided to adopt a siphon system, which comprehended the connecting a large number of small wells with an extensive siphon line that would deliver the water into a big well near the pumps at a rate of 2,500,000 gallons per day, that being about the capacity of the present pumping plant.

The main siphon line is 3000 feet long, made of twelve-, fourteen- and sixteen-inch cast-iron bell-and-spigot pipe laid from six to fourteen feet deep in the ground, the joints being leaded with unusual care, and to prevent settlement each joint is supported by a block of concrete about three feet square and eighteen inches deep, placed around the pipe after it was in place.

The wells, which are about fifty feet apart, are connected to the siphon line by a four-inch cast-iron pipe six feet long, which is provided with a gate valve at one end, so that any well or group of wells can be shut off from the line for any purpose without interfering with the working of the remainder of the system. The wells are six inches in diameter, cased with wrought-iron screw-jointed pipe, having a screen of the same size at the bottom made of perforated sheet brass. The length of the screen was determined for each well by the thickness of the gravel stratum, which varied from three to thirteen feet. The wells are so arranged that they are easily accessible for cleaning out, though they are entirely covered with earth to a depth of a foot or two, so that the soil above the wells may be farmed without interfering in any way with the working of the system.

The big well into which the water is carried by the siphon is twenty feet in diameter and about forty feet deep, walled with brick and covered with a roof that is packed with sawdust to prevent the freezing of the water in the pipes in the well. The suction pipe from the pump takes the water from this well.

The most important new feature of the entire system is an automatic device for priming the siphon line and keeping it constantly filled with water, so that air cannot accumulate at the high point on the line and obstruct the flow. This machine extracts the air from the line of pipe and wells, causing a vacuum that allows the water from the wells to fill the pipe as fast as the air is removed. It takes about two hours for the machine to remove all the air from the line.

The twelve-, fourteen- and sixteen-inch pipe of the siphon line is laid to a grade of one-half inch to the hundred feet from the well, so that the highest point on the line is where the short leg of the siphon turns down into the big well. Any air, therefore, that may leak into the siphon line or be separated from solution in the water is carried to this high point, where it is removed by the machine as fast as accumulation occurs. A vacuum of twenty-one inches has been maintained in the line without any difficulty. A vacuum gauge placed on the farthermost well shows an average of one and one-half inches less vacuum than there is at the big well when the wells are being pumped.

Tests were made, with a specially designed water meter, of the amount of water furnished by each individual well when all were in operation, which gave results varying from nothing to 130 gallons per minute, the farthermost well being, except one, the best producer in the system.

The great difference in the amount of water produced by wells in the same locality is accounted for by the fact that the gravel is quite variable, being much more open and less silted up in some wells than in others. The water takes the course of least resistance out, and if it requires more head to force it through silted gravel to one well than it does through more open gravel to another well farther away, it will go to the farther well.

The installation of this new well system has been accomplished under many difficulties, ranging from the blathering of pin-head politicians and the continued opposition of the men in charge of the pumps, to the breaking of flanges and the blowing out of gaskets twenty-four feet under ground after the work was completed. But a demonstration has been made of the fact that water can be successfully pumped from wells located more than one-half mile from the pumping station.